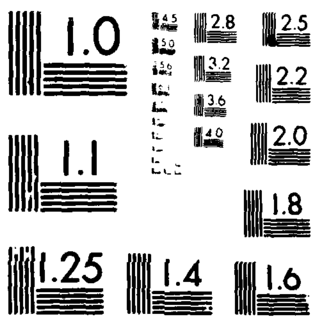
AD-A081 232   SRI INTERNATIONAL MENLO PARK CA   F/G 21/4
NAVAL FACILITY ENERGY CONVERSION PLANTS AS RESOURCE RECOVERY SY--ETC(U)
JAN 80 A G CAPPS   N00123-78-C-0868

UNCLASSIFIED   CEL-CR-80.002   NL

1 OF 1
AD
A081232

END
DATE
FILMED
3-80
DDC



MICROCOPY RESOLUTION TEST CHART

NATIONAL BUREAU OF STANDARDS-1963-A

CR 80.002

CIVIL ENGINEERING LABORATORY
Naval Construction Battalion Center
Port Hueneme, California

Sponsored by
NAVAL FACILITIES ENGINEERING COMMAND

NAVAL FACILITY ENERGY CONVERSION PLANTS AS RESOURCE RECOVERY SYSTEM COMPONENTS

January 1980

An Investigation Conducted by
SRI INTERNATIONAL
Menlo Park, California

N00123-78-C-0868

(18) CEL

Unclassified

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER (19) CR-80.002	2. GOVT ACCESSION NO.	3. RECIPIENT'S CATALOG NUMBER (9)
4. TITLE (and Subtitle) (6) Naval Facility Energy Conversion Plants as Resource Recovery System Components		5. TYPE OF REPORT & PERIOD COVERED Interim repet, for period ending Octo[redacted]r [redacted]979
		6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s) (10) Arlie G. Capps		8. CONTRACT OR GRANT NUMBER(s) (15) N00123-78-C-0868
9. PERFORMING ORGANIZATION NAME AND ADDRESS SRI International Menlo Park, California		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS (16) 63721N: Y0817SL Y4121.006.01.002C
11. CONTROLLING OFFICE NAME AND ADDRESS Civil Engineering Laboratory Naval Construction Battalion Center Port Hueneme, California		12. REPORT DATE (11) [redacted]
		13. NUMBER OF PAGES 65
14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office) Naval Facilities Engineering Command 200 Stovall Street Alexandria, Virginia		15. SECURITY CLASS. (of this report) U
		15a. DECLASSIFICATION DOWNGRADING SCHEDULE

(11) Jan 80

(12) 68

16. DISTRIBUTION STATEMENT (of this Report)

(17) Y0817SL

This document has been approved for public release and sale; its distribution is unlimited.

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Energy recovery from waste, waste fuels, solid waste management, resource recovery, energy conservation

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

This interim report addresses concepts for recovering energy from solid waste by using Naval facilities steam plants as principle building blocks of candidate solid waste/resource recovery systems at Navy installations. The Navy steam plants were first characterized in terms relevant to firing or cofiring waste derived fuels (WDF). The steam plants and their boilers

next page

DD FORM 1 JAN 73 1473 EDITION OF 1 NOV 65 IS OBSOLETE

Unclassified

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

410281

JB

were then classified in a simple, eight-class scheme. Size (designed heat input capacity, 10^6 Btu/hr) and type of primary fuel were the basic parameters of the classes. Four size classes and two types of primary fuel buring capabilities (coal, noncoal) were selected, and distributions of plants planned for 1985 were plotted for each of the eight classes.

Four alternatives means for utilizing WDF - adding incinerators, replacing boilers, modifying existing boilers, and making hybrid conversions - were considered for each class. Incineration and modification of existing boilers were emphasized. These alternatives appeared to be the most feasible ones for near-term implementation.

Problems encountered, system modifications required, and costs associated with the alternatives in the classes were defined as clearly as the accuracy of the available data would allow.

The major conclusions of this portion of the project are:
Waste Derived Fuel

. Although it is technically feasible to adapt Navy energy conversion systems to fire (WDF) in one or more of its forms, the optimal form selected should be a site-specific total system.

. Near- to intermediate-term programs should probably continue to give first consideration to waterwall incinerators and to the cofiring of solid WDF in coal-capable plants, because these options are the ones most completely developed and documented.

. Package incinerators and conversions of oil burning plants to fire a fluff form of solid waste fuel may be the options with the greastest potential for the intermediate term because waterwalls would be uneconomical in many small plants and because the majority of medium-sized oil-burning plants will not be converted to burn coal. and

. Pyrolytic processes to produce gaseous and liquid fuels have not been sufficiently developed as yet to be specified for commercial operation. However, these forms of WDF have widespread potential applicability. If they (liquids in particular) become available, they could become the most cost-effective alternatives; using them would minimize the necessary modifications of existing energy conversion systems. Probably 5 years or more of development and testing will be needed before the future of pyrolysis is clear.

CONTENTS

LIST OF ILLUSTRATIONS ii

LIST OF TABLES iii

PREFACE iv

I INTRODUCTION 1

II STUDY APPROACH 5

III ANALYSES AND FINDINGS 14

IV CONCLUSIONS AND RECOMMENDATIONS 38

APPENDICES

APPENDIX A DESCRIPTION OF COMPUTER DATA MANAGEMENT PROCEDURES A-1

APPENDIX B MODIFIED WASTES CHARACTERIZATION PROCEDURE B-1

APPENDIX C LANDFILL TECHNOLOGY COSTS PER SITE BY SITE SIZE C-1

APPENDIX D WATER QUALITY ISSUES RELATED TO NAVY SOLID WASTE DISPOSAL OPERATIONS D-1

LIST OF ILLUSTRATIONS

1. How NESO R^4 Data is Input To SRI Computer Program SIR 10
2. Number of Naval Complexes by TPD_5 23
3. Number of Naval "Counties" by TPD_5 25
4. Collection, Transportation, and Disposal Cost by PWC and Private Contractors 29
5. PWC Collection, Transportation, and Disposal Cost for 3 System Sizes 33

LIST OF TABLES

1. Completed Card R^4 Survey Data Available July 1978 6

2. Data Inputs for Analysis of SRI's Solid Waste Characterization Technique. 9

3. Estimated Densities and Statistics by Generator/Origin 15

4. Estimated Densities and Statistics by Waste Type 16

5. Waste Type, by Generator/Origin 17

6. NAS North Island Waste Stream by Volume of Generation/Origin Types 18

7. NAS North Island Waste Stream by Volume of Waste Types and Total Waste 19

8. Solid Waste Characterization Survey--NAS North Island, California. 20

9. Naval Activities--Complex, by TPD_5 22

10. Naval Activities--Counties, by TPD_5 24

11. Naval Activities--Complexes, by Total TPD_5 per TPD_5 Class 26

12. Naval Activities--Counties, by Total TPD_5 per TPD_5 Class 27

13. Collection, Transportation, and Disposal Costs by TPD_5 by PWC 30

14. Collection, Transportation, and Disposal Costs by TPD_5 by Private Contractor 31

15. Characteristics of Reported Navy Solid Waste Landfill sites 34

16. Remaining Site Life for Selected Navy Solid Waste Activities 35

17. Distribution of Navy Solid Waste Facilities by Size 35

18. Estimated Costs of Upgrading Navy Landfills to Meet Various RCRA Requirements 36

PREFACE

This report covers two of five separate, but related, tasks performed under Contract N00123-78-C-0868 to support the Navy's Advanced Development Plan, Recovery of Materials and Energy from Solid Waste, Product No. 1--Definition and Analyses of Candidate Resource Recovery Systems for FY 1978. The tasks reported herein are: (1) solid waste generation rates and composition and (2) solid waste collection and disposal practices.

I INTRODUCTION

The Solid Waste Disposal Act of 1965 and its amendments (the Resource Recovery Act of 1970 and the Resource Conservation and Recovery Act of 1976) make federal agencies responsible for ensuring "compliance with the guidelines (for solid waste recovery, collection, separation, and disposal systems) recommended (by EPA) under Section 209 and the purposes of the Act..." Over the past 14 years, this series of laws has shifted the emphasis from landfilling solid wastes to salvaging, processing, and reusing anything of value remaining in those wastes. Specifically, the Resource Conservation and Recovery Act of 1976 (RCRA)* phases out open dumps and strongly encourages environmentally sound methods to dispose of solid waste.

RCRA especially encourages the recovery of materials and *waste-derived fuels to the maximum extent practicable at* federal facilities, while complying with all state and local requirements as well. More than 200 Navy installations may come under local and state scrutiny of their compliance with such requirements.

Therefore, the Navy needs to survey its activities and define typical situations that could become issues as RCRA begins the enforcement phase within a few years.

An immediate aim of the Navy solid waste research program is to identify, quantify, and characterize the recoverable materials contained in the Navy waste streams and to compile information on how these materials are handled (i.e., collected and disposed of) at typical Navy

---

*Public Law 94-580

installations. With an activity-by-activity situation analysis having been developed as a base of information, the Navy can prepare cost-effective resource recovery programs to meet its mission-oriented needs and, at the same time, cooperate as opportunities arise in meeting state and local resources recovery program objectives. The work described here concentrated on collecting and analyzing available data about current solid waste management practices within the Navy, and on developing a set of realistic descriptions of typical Navy solid waste and solid waste handling practices.

The research reported in this document is therefore divided into the two major Navy solid waste management areas described above: waste composition and generation rate, and solid waste collection and disposal practices.

Waste Composition and Generation Rate

In this subtask we analyzed the data concerning the solid waste generated at Navy facilities for scenario development. Second, we evaluated data obtained previously in limited tests of an innovative solid waste estimating technique against comparable data obtained in the Navy's currently prescribed standard R^4 surveys,* which were performed at numerous Navy activities during 1976-78.

In the first subtask area, data available from the NACWIS** data base, including R^4 surveys conducted under the direction of the Naval Environmental Support Office (NESO), were compiled and analyzed. Navy facilities were listed in classes according to the amount of waste

---

* R^4 Decision Guide, NESO 20.2-008, Naval Environmental Support Office (August 1975; rev. April 1976). (R^4 is the Navy's Recovery and Reuse of Refuse Resources Program.)

**NACWIS--Naval Environmental Protection Support Service, Naval Environmental Support Office; Solid Waste Generation Summary Report.

they reportedly generated. This information was intended to be used in the development of scenarios representing solid waste management situations typical of Navy activities.

Given the difficulties of building a reliable data base about the waste, in the second subtask we examined a simplified technique for estimating quantities of the various recoverable resources generated by a Navy installation. This technique was also tested against data obtained from the R^4 surveys mentioned above. The test was aimed at evaluating this relatively low-cost technique for possible use in augmenting Navy solid waste data to enable adequate field planning, selection, and preliminary sizing of Navy resource recovery systems. The technique requires a series of field observations of the volumes of waste generated and the waste's origin to estimate weight and composition. Once the bulk densities are thus derived, a few periodic volume observations will establish trends and cycles.

Solid Waste Collection and Disposal Practices

In this task we compiled existing information concerning current Navy practices for handling its solid waste. This information was also derived from R^4 survey results obtained by the Navy. The information includes indication of the type of personnel involved in the collection--whether civil service or contractor; the type of disposal methods used, whether government or contractor-operated; useful life of landfill sites; and whether the landfill is on Navy property. The format in which the data are compiled was intended to enable the establishment of classes for collection and disposal methods and the indication of the number of Naval installations in each class.

This task included a brief analysis of how Navy and all other landfills will be affected by RCRA and the Safe Drinking Water Act (SDWA).*

---

*Public Law 93-523.

Possible required actions, the time frame for the actions, and their costs are highlighted because in the near future, these two laws are certain to focus attention on disposal practices and, in particular, on landfilling. These data must be stressed in classing solid waste management practices in view of the critical role of landfilling, regardless of any other consideration.

II STUDY APPROACH

Waste Composition and Generation Rate

In conducting this phase of the research, SRI followed four steps:

(1) Review and compilation of existing NESO-NACWIS data

(2) Development of procedures for classifying Navy activities according to the quantity of waste generated

(3) Analysis of the applicability and potential cost effectiveness of an innovative technique for estimating the quantity and composition of waste generated by a Naval activity

(4) Test of the technique analyzed in (3) to evaluate the adequacy of information it produces.

SRI's activities under Steps 1 through 4 are briefly described below. The results of this phase are reported in Chapter III.

Step 1--Review and Compilation of Existing NESO-NACWIS Data

SRI's project team met in late May 1978 with representatives of NESO's Environmental Information and Field Operations Departments. During this 1-day meeting at Port Hueneme, we arranged to obtain the NACWIS data file and other pertinent information on Navy solid waste.

In July, a second meeting was held at Port Hueneme to obtain detailed information about all completed R^4 surveys (see Table 1) then on file in the NACWIS data bank.

Table 1

COMPLETED R^4 SURVEY DATA AVAILABLE JULY 1978

Activity	Date of Survey
NS Mayport	January 1976
PWC Pensacola	January 1976
NAS Chase Field	February 1976
NAS Corpus Christi	February 1976
NAS Memphis	May 1976
NSA New Orleans	March 1976
NSC Oakland	March 1976
NAS Alameda	April 1976
NAS Memphis	May 1976
NRMC Oakland	June 1976
NSA San Francisco	June 1976
PWC San Francisco	June 1976
NSY Long Beach	November 1976
NAB Coronado	January 1977
NAD McAlester	March 1977
NAS Moffett Field	May 1978

Step 2--Development of Procedures for Classifying Navy Activities by the Quantity of Waste Generated

The NACWIS information on the generation of solid waste obtained in the May 1978 meeting at Port Hueneme, as well as data from the EFD Regionalization Feasbility studies, CERL studies, and A&E studies were placed on an SRI computer using the Scientific Information Retrieval (SIR) data management system programs (see Appendix A for details).

Using these computer programs, the distributions of Naval activities by classes of tons of solid waste generated per day were determined and sorted on:

- Uniform Identification Code (UIC)
- Engineering Field Division (EFD)
- Standard Metropolitan Statistical Area (SMSA)
- Activity Type (e.g., Air Station)
- Complexes*
- Counties.

No attempt was made to obtain distributions based on reported waste compositions for the categories above. An exercise to correlate waste types with generator (origin) was performed and is discussed below (see Table 5).

---

*Complexes (UICs in a locale sharing common public works support and utilities) were defined by NESO for the purpose of this solid waste research.

Step 3--Analysis of an Innovative Navy Solid Waste Characterization Technique

Through experience gained by experimenting (under previous contracts) with the standard R^4 method prescribed by the Navy of performing waste characterization surveys, SRI developed a modified survey technique that appeared to reduce the effort required to perform such surveys. It was also believed that problems inherent in the standard method--for example, projecting long-term waste characterization on the basis of a short (10-12 day) survey by using national "average densities" to convert Navy waste volumes to weights, and sensitivity to observer bias--could be mitigated by using this new technique.

Limited evidence had already been obtained that the SRI innovative technique actually did provide satisfactory waste characterization data. This evidence was obtained by employment of the technique in three field surveys. However, more evidence was needed before a final judgment could be made about the adequacy of the data acquired and the feasibility of the Navy adopting the modified technique. Extensive field observations (raw data) in support of surveys reported in the NACWIS allowed us to apply the analytical procedures of the new technique to data collected by others. We conjectured that an analysis of the significant data bank might provide additional evidence about whether the new technique was useful. The application of the analytical procedures to the raw data in the NACWIS R^4 data bank is discussed below.

The detailed information on the R^4 surveys obtained from NESO was screened, coded, and entered into SIR by waste origins and waste type (see Table 2); incomplete or obviously inaccurate data were not entered.

Table 2

DATA INPUTS FOR ANALYSIS OF SRI's
SOLID WASTE CHARACTERIZATION TECHNIQUE

Generation Origins	Code	Waste Type	Code
Housing	g_1	Paper	t_1
Dormitory	g_2	Cardboard	t_2
Office/administrative	g_3	Mixed office	t_3
Commercial	g_4	Residential	t_4
Medical	g_5	Wood	t_5
Ships	g_6	Dormitory	t_6
Treatment plant	g_7	Ship	t_7
Food services	f_8	Yard	t_8
Storage	g_9	Food	t_9
Recreation	g_{10}	Metals	t_{10}
Other	g_{11}	Glass	t_{11}
		Sewage	t_{12}
		Construction	t_{13}

Figure 1 depicts how NESO-R[4] data were entered into the SIR program. Approximately 900 data cards were placed in SIR. These data were then used to obtain--for each activity--the appropriate load weight and bulk densities by generator origins and waste types.

For example, load 014 (shown in Figure 1) had been observed as 4 yd^3 and its weight was recorded as 460 lb. The bulk density for office/administrative (g_3) was then calculated as:

$$y_{014}/g_3 = \frac{460 \text{ lb}}{4 \text{ yd}^3} = \frac{115 \text{ lb}}{\text{yd}^3}$$

EXAMPLE NESO – R^4 PRINTOUT

COLLECTION DATE	LOAD NUMBER	COLLECTOR NUMBER	CONTAINER SIZE (YD^3)	VOLUME FILLED	TYPE WASTE	VOLUME (YD^3)	COMP WEIGHT (VXD = LBS)
BULDING No. - 921		ORIGIN – OFFICE/ADMINISTRATIVE					
760120	014	1	8	4.0	PAPER	1.0	82.0
					CARDBOARD	1.0	82.0
					MIXED OFFICE	1.0	82.0
					WOOD	1.0	267.0

SRI DATA INPUTS

- LOAD = 014 = y_{014}
- GENERATION ORIGIN = g_3
- WASTE TYPE = t_1, t_2, t_3, AND t_5
- VOLUME = 1 CUBIC YARD EACH

FIGURE 1. HOW NESO R^4 DATA IS INPUT INTO SRI COMPUTER PROGRAM SIR

Summing the data by generator origins and waste type produced approximately 800 bulk densities. These densities were then plotted to obtain a frequency distribution. Obvious errors in the data were rejected, and the procedures above (summing, obtaining densities, and frequency distributions) were repeated. This process was also performed for waste type densities.

Using the data obtained in the above methods, two separate multiple regressions (see Appendix A for complete details) were then carried out to obtain typical densities:

(1) For each generator origin
(2) For each waste type.

For each generator origin density, a vector of waste stream elements was also obtained. The weight of load y_{n-1} is determined in Eq. (1) where:

A_{n-1}, B_{n-1}, ..., K_{n-1} are the volumes of generation origins g_1, g_2, ..., g_{11}, respectively.

and

a_i, b_i, ..., k_i are the percent of waste types t_i, t_j, ..., t_u, respectively.

$$y_{n-1}=A_{n-1}g_1\begin{pmatrix} a_1t_1 \\ a_2t_2 \\ a_3t_3 \\ a_4t_4 \\ a_5t_5 \\ a_6t_6 \\ a_7t_7 \\ \cdot \\ \cdot \\ \cdot \\ a_{13}t_{13} \end{pmatrix} + B_{n-1}g_2\begin{pmatrix} b_1t_1 \\ b_2t_2 \\ b_3t_3 \\ b_4t_4 \\ \cdot \\ \cdot \\ \cdot \\ b_{13}t_{13} \end{pmatrix} +\dots+k_{n-1}g_{11}\begin{pmatrix} k_1t_1 \\ k_2t_2 \\ k_3t_3 \\ k_4t_4 \\ \cdot \\ \cdot \\ \cdot \\ k_{13}t_{13} \end{pmatrix} \quad (1)$$

Finally, generator densities and waste elements were compared and, when possible, combined to obtain the simplest equation--that would still predict the total weight and weight of components in a given waste load with $\pm 5\%$ accuracy.

Step 4--Testing the Technique Analyzed in Step 3

The density factors produced in Step 3 were then applied to the observations (raw data) SRI had collected in its field survey of the North Island Naval Air Station. The estimated weights arrived at by using these factors were compared with the actual weights obtained during the North Island survey. Chapter III shows the results of this comparison.

Solid Waste Collection and Disposal Practices

Three steps were completed in conducting this research:

(1) Reviewing and compiling existing NACWIS data

(2) Categorizing major Naval installations in terms of their solid waste handling and disposal practices, and identifying specific installations included in each category

(3) Determining the land use/water quality issues related to Navy solid waste practices and landfilling in particular.

Each of the above steps is described below:

Step 1--Compiling Existing NACWIS Data on Navy Solid Waste Collection and Disposal

This step comprised two parts. First, we analyzed solid waste collection and transportation data and calculated costs per ton for entry into the SIR programs for each activity (by UICs). Second, we calculated current disposal costs per ton for each UIC and entered them into the SIR data base as a function of landfill type and remaining life.

Step 2--Categorizing Naval Installations in Terms of Waste Collection and Disposal

To typify Naval activities by solid waste collection and disposal the information entered into the SIR program in Step 1 was first sorted by:

(a) Navy or non-Navy collection and handling

(b) Incremental weight categories.

The Naval activities were then sorted by waste disposal attributes:

(a) Landfill type

(b) Landfill life

(c) Weight of waste per day.

Step 3--Determining Water Quality Issues Related to Navy Solid Waste Disposal Operations

For this step we reviewed two major laws--the Resource Conservation and Recovery Act of 1976 (RCRA) and the Safe Drinking Water Act (SDWA)--to determine the impacts and issues of solid waste land disposal (principally landfilling) related to water quality. This step employed the information obtained in Steps 1 and 2 to estimate the cost of present and future land disposal of solid waste.

III ANALYSES AND FINDINGS

Waste Composition and Generation Rate

Waste Composition

The detailed raw information from the NACWIS R^4 surveys was manipulated as outlined in Chapter II. Then we performed two separate multiple linear regressions to obtain bulk densities for waste from each origin and each waste type. Table 3 shows the results in terms of generator/origin densities. Table 4 gives the waste type (element) densities. Table 5 characterizes the waste by the percent (by weight) of each waste type contained in each generator/origin component of a Navy waste stream.

These statistically defined data for typical Navy densities were used to convert the volume* observations from SRI's survey of NAS North Island (shown in Tables 6 and 7, by generator/origin and waste type, respectively) into weight data. Generator/origins data were multiplied by the densities shown in Table 3 to obtain the information given in Table 8. From Table 8 we observe that 50% of the actual weights of North Island waste fall into cases within the 95% confidence interval of the derived weights. Thus, we conclude that the data obtained using the low-cost, volume estimating techniques are probably good enough to provide a first estimate of a facility's waste stream. This modified waste characterization procedure is detailed in Appendix B.

---

*As explained above, the SRI technique developed for predicting the waste streams' weight and composition is based on field observations of the volumes generated and their origin.

Table 3

ESTIMATED DENSITIES AND STATISTICS
BY GENERATOR/ORIGIN

Generator/Origin	Density (lb/yd^3)	Standard Error (lb/yd^3)	95% Confidence Interval (lb/yd^3)*	Student's t-Value
Housing	91	6.9	77-104	13.1
Office	66	4.0	58-73	16.5
Industrial	113	5.0	103-123	22.6
Commercial	56	12.3	32-81	4.6
Medical	69	24.1	22-116	2.9
Ships	144	9.7	125-163	14.8
Treatment plants	346	1116	-1846-2537	0.3**
Food service	110	14.3	82-138	7.7
Storage areas	55	9.2	37-73	6.0
Recreation areas	81	27.8	26-135	2.9
Dormitories	50	10.4	30-71	4.8

*The statistical 95% confidence limits about the estimated densities are shown in this table. These confidence limits assume that the densities are normally distributed. This is not strictly true because it is theoretically impossible for a density to be less than zero. The violations of the normality assumption is expected to be most severe when the estimated density is close to zero or when its standard deviation is large. In either of these cases the lower confidence limit, based on the normal distribution, may be less than zero.

**A student's t-test, using a significance level of 0.05, was used to determine if the estimated densities are statistically significant. Accordingly, t-values of less than 1.9 are not statistically significant. Thus, density values associated with such t-values are considered unreliable for use in this model.

Table 4

ESTIMATED DENSITIES AND STATISTICS
BY GENERATOR/ORIGIN

Waste Type	Density (lb/yd^3)	Standard Error (lb/yd^3)	95% Confidence Interval (lb/yd^3)*	Student's t-Value
Paper	56	7.5	41-70	7.4
Cardboard	44	6.4	31-56	6.8
Mixed office	75	3.3	68-81	22.9
Residential	98	8.8	81-116	11.2
Wood	158	16.7	126-191	9.5
Yard	138	13.8	111-165	10.0
Food	477	29.3	419-535	16.3
Metals	117	66.6	-14-248	1.8**
Dormitory	56	10.7	35-77	5.3
Sewage	333	195.9	-52-717	1.7**
Glass	712	1052	-1354-2778	0.7**
Ship	290	91.7	110-470	3.2
Construction	850	706	-536-2236	1.2**

*The statistical 95% confidence limits about the estimated densities are shown on this table. These confidence limits assume that the densities are normally distributed. This is not strictly true because it is theoretically impossible for a density to be less than zero. The violations of the normality assumption is expected to be most severe when the estimated density is close to zero or when its standard deviation is large. In either of these cases the lower confidence limit, based on the normal distribution, may be less than zero.

**A student's t-test, using a significance level of 0.05, was used to determine if the estimated densities are statistically significant. Accordingly, t-values of less than 1.9 are not statistically significant. Thus, density values associated with such t-values are considered unreliable for use in this model.

Table 5

WASTE TYPE, BY GENERATOR/ORIGIN
(Percent by Weight)

Generator/Origin	Paper	Cardboard	Plastic/ Rubber	Wood	Yard Waste	Food Waste	Metal	Glass	Inerts	Construction
Housing	48%	6%	3%	5%	9%	12%	7%	6%	3%	0%
Office	75	21	0	2	2	t	t	0	0	0
Industrial	54	22	t	12	8	2	2	0	t	0
Commercial	47	52	0	1	t	t	t	0	0	0
Medical	85	14	1	1	t	0	t	0	0	0
Ships	38	26	1	12	3	14	4	0	0	0
Food service	47	33	3	1	1	13	2	t	0	0
Storage areas	68	23	1	4	4	t	t	0	0	0
Recreation areas	49	30	2	1	7	5	3	2	0	0
Dormitories	22	72	t	1	1	2	2	0	0	0

t = trace.

Rows may not add to 100 due to rounding.

Table 6

N.A.S. NORTH ISLAND WASTE STREAM BY VOLUME OF GENERATION/ORIGIN TYPES
(yd^3)

Route No.	Housing	Office	Industrial	Commercial	Medical	Ships	Food Service	Recreation Areas	Dormitories	Total
120	25.50	108.75	6.25	0	0	30.00	6.75	5.00	0	182.25
110	0	140.00	3.00	0	7.00	31.25	10.75	0	0	192.00
210	0	69.50	5.00	15.00	0	0	13.50	0	52.00	155.00
120	0	140.75	5.00	0	0	41.25	15.25	0	0	202.25
220	0	14.50	29.00	23.75	0	7.50	0	0	0	74.75
110	0	123.00	0	0	1.50	31.25	13.50	0	0	169.25
210	0	52.75	6.50	37.75	0	0	20.25	5.75	34.75	157.75
121	0	117.50	0	0	0	0	4.50	0	0	122.00
122	0	0	0	0	0	26.25	0	0	0	26.25
110	0	150.00	0	0	2.25	0	18.50	0	0	170.75
210	5.25	55.25	0	27.50	0	0	19.50	0	26.50	134.00
120	0	105.50	1.50	0	0	11.25	3.75	0	0	122.00
110	0	169.00	0	0	3.00	0	18.25	0	0	190.25
120	0	106.00	0	11.75	0	0	8.25	0	0	126.00
210	0	94.25	0	33.75	0	3.75	20.25	6.00	9.75	167.75
110	0	153.00	0	0	1.50	0	8.50	0	0	163.00
210	0	53.25	0	20.50	0	0	8.75	0	54.50	137.00
120	0	116.75	5.00	0	0	21.25	5.25	1.00	0	149.25
110	0	144.25	0	0	1.50	0	9.25	0	0	155.00
210	19.00	49.25	0	16.50	0	0	15.75	6.00	28.75	135.25
120	0	100.50	20.00	0	0	5.00	8.25	0	0	133.75
220	0	34.75	0	20.75	0	0	9.00	0	6.00	70.50
110	0	128.25	0	0	3.75	30.00	12.50	0	0	174.50
121	0	86.00	1.00	0	0	0	8.25	0	0	95.25
122	0	0	0	0	0	30.00	0	0	0	30.00
110	0	123.25	0	0	6.00	32.50	3.00	0	0	164.75
210	0	60.50	0	37.50	0	0	21.50	0	40.25	159.75
121	0	131.75	0	0	0	0	26.00	0	0	157.75
122	0	0	0	0	0	10.00	0	0	0	10.00
221	0	25.25	0	0	0	0	0	0	0	25.25
222	0	0	0	0	0	27.50	0	0	0	27.50
110	0	125.50	0	0	2.25	30.00	17.25	0	0	175.00

Table 7

NAS NORTH ISLAND WASTE STREAM
BY VOLUME OF WASTE TYPES, AND TOTAL WEIGHT

Date (yr/mo/day)	Route*	Total Weight (lb)	Paper	Cardboard	Mixed Office	Residential	Ship Waste	Dorm Waste	Wood	Yard Waste	Metal	Other	Total	Bulk Density (lb/yd^3)
			Volume (yd^3)											
77/06/20	120	16,180	2.03	27.70	107.40	24.25	17.75	0.00	1.52	1.00	0.00	0.60	182.25	88.78
77/06/21	110	16,000	0.00	13.91	147.18	0.00	27.51	0.00	0.90	0.50	0.00	2.00	192.00	83.33
77/06/21	210	15,400	25.78	50.11	40.08	0.00	0.00	31.26	1.95	5.72	0.00	0.10	155.00	99.35
77/06/21	120	16,360	13.25	20.41	131.59	0.00	36.50	0.00	0.50	0.00	0.00	0.00	202.25	80.89
77/06/21	220	7,550	24.82	19.98	12.60	0.00	6.25	0.00	10.40	0.75	0.00	0.00	74.75	101.00
77/06/22	110	14,260	0.00	9.02	127.10	0.00	30.63	0.00	0.00	2.50	0.00	0.00	169.25	84.25
77/06/22	210	12,510	21.86	81.88	15.07	1.87	0.00	31.10	1.47	4.50	0.00	0.00	157.75	79.30
77/06/22	121	9,630	17.50	22.74	80.16	0.60	0.00	0.00	0.00	0.00	0.00	1.00	122.00	78.93
77/06/22	122	2,770	0.00	1.00	3.50	0.00	21.75	0.00	0.00	0.00	0.00	0.00	26.25	105.52
77/06/23	110	15,220	0.00	11.82	158.93	0.00	0.00	0.00	0.00	0.00	0.00	0.00	170.75	89.14
77/06/23	210	14,310	44.41	43.09	25.42	8.10	0.00	11.04	1.32	0.62	0.00	0.00	134.00	106.79
77/06/23	120	9,990	5.00	11.39	91.73	0.00	8.88	0.00	1.00	4.00	0.00	0.00	122.00	81.89
77/06/24	110	13,530	0.00	18.94	169.86	0.00	0.00	0.00	0.45	0.00	0.00	1.00	190.25	71.12
77/06/24	210	18,770	21.77	50.54	19.13	5.25	0.00	31.13	6.00	3.38	0.30	0.00	137.50	136.51
77/05/24	120	8,390	0.00	21.54	99.91	1.95	0.00	0.00	2.60	0.00	0.00	0.00	126.00	66.59
77/06/25	210	14,630	17.57	53.74	84.81	4.20	3.38	3.00	0.00	0.33	0.22	0.45	167.75	87.21
77/06/27	110	13,780	0.00	18.62	139.53	0.00	0.00	0.00	0.80	3.05	0.00	1.00	163.00	84.54
77/06/27	210	14,240	16.60	33.52	37.25	0.00	0.00	41.50	2.20	5.63	0.30	0.00	137.00	103.94
77/06/27	120	12,490	10.00	23.32	97.75	3.07	5.50	0.00	5.12	4.50	0.00	0.00	149.25	83.68
77/06/28	110	13,360	0.00	11.60	134.70	1.95	0.00	0.00	0.00	3.75	0.00	3.00	155.00	86.19
77/06/28	210	15,610	16.70	31.30	34.13	17.50	0.00	19.00	2.07	14.25	0.30	0.00	135.25	115.42
77/06/28	120	11,260	0.00	17.19	100.73	0.00	0.00	0.00	14.63	0.60	0.00	0.60	133.75	84.19
77/06/28	220	8,500	6.94	24.26	27.59	1.51	0.00	0.00	0.00	9.90	0.00	0.30	70.50	120.57
77/06/29	110	15,370	10.00	12.74	119.51	0.00	30.00	0.00	0.00	1.25	0.00	1.00	174.50	90.95
77/06/29	210	15,710	23.42	44.93	41.07	7.50	0.00	22.95	6.00	6.38	0.00	0.00	152.25	103.19
77/06/29	121	10,600	0.00	10.86	72.91	6.38	0.00	0.00	1.90	1.50	1.50	0.20	95.25	111.29
77/06/29	122	4,260	0.00	0.00	0.00	0.00	30.00	0.00	0.00	0.00	0.00	0.00	30.00	142.00
77/06/30	110	15,070	0.00	9.28	121.97	0.60	31.50	0.00	0.00	0.40	0.00	0.00	164.75	91.47
77/06/30	210	14,390	24.53	56.31	46.87	0.00	0.00	25.60	1.50	6.94	0.00	0.00	159.75	90.08
77/06/30	121	11,880	3.00	21.20	127.20	5.75	0.00	0.00	0.00	0.60	0.00	0.00	157.75	75.31
77/06/30	122	1,010	0.00	0.00	0.00	0.00	10.00	0.00	0.00	0.00	0.00	0.00	10.00	101.00
77/06/30	221	1,340	13.20	8.62	3.42	0.00	0.00	0.00	0.00	0.00	0.00	0.00	25.25	53.09
77/06/30	222	3,100	0.00	0.00	0.00	0.00	27.50	0.00	0.00	0.00	0.00	0.00	27.50	112.73
77/07/01	110	15,420	0.00	20.02	124.76	3.22	25.00	0.00	0.00	0.00	0.00	2.00	175.00	88.11

*Route Numbers:
100 Series = Route 1; 200 series = Route 2.
10 Series = First half of collection route; 20 series = second half of collection route.
0 Series = Only weight recorded for route; 1 = first of two weights recorded for route; 2 = second weight recorded for same route.

Table 8

SOLID WASTE CHARACTERIZATION--NAS NORTH ISLAND, CALIFORNIA
Actual Weights and Estimated Weights
Using Generation/Origin Type Densities
(Best Fit and 95% Confidence Interval)

Date (yr/mo/day)	Route*	Actual Total Weight (lb)	Estimated Weight Derived by Generation Type (lb)	Derived Weights 95% Confidence Interval (lb)[3]	
77/06/20	120	16,180	15,615	13,349	17,857
77/06/21	110	16,000	15,690	13,371	17,979
77/06/21	210	15,400	10,035	7,693	12,459
77/06/21	120	16,360	17,415	15,086	19,719
77/06/21	220	7,550	6,656	5,526	7,772
77/06/22	110	14,260	14,156	12,180	16,110
77/06/22	210	12,510	10,735	7,790	13,746
77/06/22	121	9,630	8,198	7,184	9,199
77/06/22	122	2,770	3,785	3,281	4,279
77/06/23	110	15,220	12,020	10,267	13,764
77/06/23	210	14,310	9,103	6,883	11,380
77/06/23	120	9,990	9,121	7,988	10,238
77/06/24	110	13,350	13,291	11,365	15,204
77/06/24	120	8,390	8,518	7,201	9,829
77/06/25	210	14,630	11,815	9,124	14,522
77/06/27	110	13,7890	11,069	9,604	12,516
77/06/27	210	14,240	8,316	6,098	10,625
77/06/27	120	12,490	11,943	10,400	13,462
77/06/28	110	13,360	11,577	9,159	11,981
77/06/28	210	15,610	9,520	7,158	11,933
77/06/28	120	11,260	10,481	9,191	11,751
77/06/28	220	8,500	4,734	3,598	5,886
77/06/29	110	15,370	14,366	12,296	16,449
77/06/29	121	10,600	6,658	5,768	7,540
77/06/29	122	4,260	4,325	3,750	4,890
77/06/30	110	15,070	13,512	11,589	15,405
77/06/30	210	14,390	10,439	7,680	13,279
77/06/30	121	11,880	11,491	9,774	13,206
77/06/30	122	1,010	1,442	1,250	1,630
77/06/30	221	1,340	1,656	1,465	1,843
77/06/30	222	3,100	3,965	3,438	4,483
77/07/01	110	15,420	14,602	12,494	16,694

*Route Numbers:
100 Series = Route 1; 200 series = Route 2.
10 Series = First half of collection route; 20 series = second half of collection route.
0 Series = Only weight recorded for route; 1 = first of two weights recorded for route; 2 = second weight recorded for same route.

Waste Generation Rate

NACWIS data were reviewed critically and analyzed to typify the waste generation ratio of Naval activities. Table 9 and Figure 2 depict existing Naval activities complexes* by solid waste weight classes. Table 10 and Figure 3 show the same information for the UIC grouped by counties.

In reviewing these data for characteristics of Navy solid waste, we note that currently 76% of the Navy complexes (67% of the county groups) generate less than 20 TPD_5 (see Tables 9 and 10). However, Tables 11 and 12 show that in tonnages by complex only 23% of the total solid waste generated in the Navy is generated by complexes in the "less than 20 TPD_5" class (only 12% in the same size range for county groupings.)

Size category break points were chosen at 50, 100, and greater than 100 TPD_5 on the basis of Tables 9-12. It is obvious that the majority of the Navy's solid waste management problems are likely to exist in the less than 100 TPD_5 class, with a substantial portion of these problems in the sizes less than 20 TPD_5.

We could find no indication that existing activities, and, hence, their resulting waste streams, would change dramatically in the next 5 years. We therefore concluded that Navy activities, complexes, and counties could be appropriately characterized by waste stream sizes of 0-20 TPD_5, 21-50 TPD_5, 51-100 TPD_5, and greater than 100 TPD_5.**

---

*See Volume IV for a detailed explanation of UICs, complexes, and counties. A complex, as used here, is a grouping of adjacent or nearly adjacent UICs with one major UIC as the host activity. This is important because Navy public works functions and utilities are often consolidated in a locality to avoid duplication.

**In light of a recent directive designating the Navy as the lead agency in SMSAs for studying the feasibility of regionalization of resource recovery, it was of interest to note that 74% of the complexes are within SMSAs.

Table 9

NAVAL ACTIVITIES--COMPLEX
BY TPD5

Lower Limit (TPD5)	Upper Limit (TPD5)	Absolute Frequency	Relative Frequency (Percent)	Cumulative Relative Frequency (Percent)
0.00	5.00	91.00	53.53	53.53
5.00	10.00	16.00	9.41	62.94
10.00	15.00	12.00	7.06	70.00
15.00	20.00	11.00	6.47	76.47
20.00	25.00	7.00	4.12	80.59
25.00	30.00	7.00	4.12	84.71
30.00	35.00	3.00	1.76	86.47
35.00	40.00	5.00	2.94	89.41
40.00	45.00	3.00	1.76	91.18
45.00	50.00	5.00	2.94	94.12
50.00	55.00	2.00	1.18	95.29
55.00	60.00	1.00	.59	95.88
60.00	65.00	1.00	.59	96.47
65.00	70.00	2.00	1.18	97.65
70.00	75.00	1.00	.59	98.24
80.00	85.00	1.00	.59	98.82
135.00	140.00	1.00	.59	99.41
155.00	160.00	1.00	.59	100.00
TOTAL		170.00	100.00	100.00

NOTE: Columns may not add because of rounding.

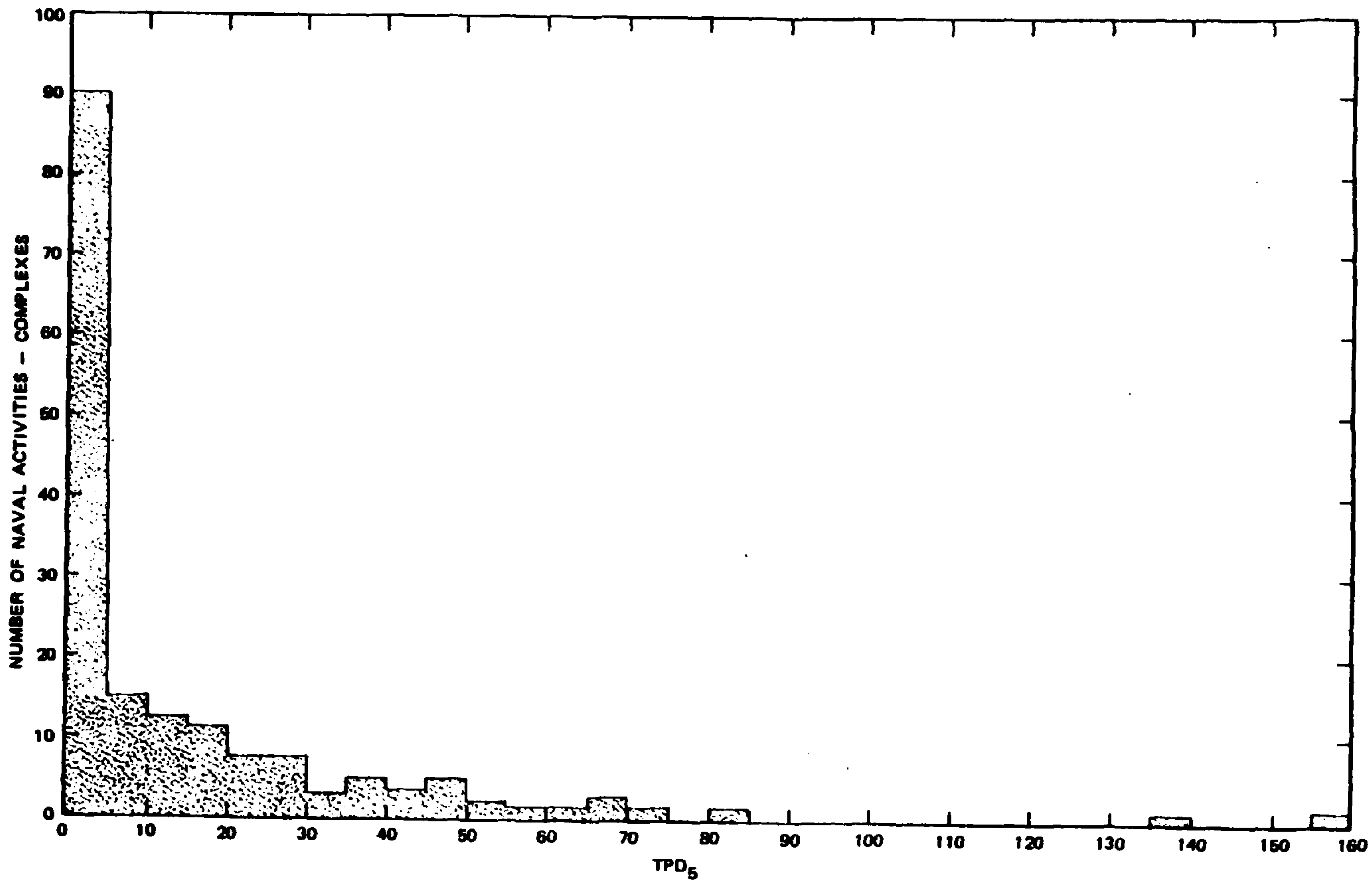


FIGURE 2. NUMBER OF NAVAL COMPLEXES BY TONS PER DAY (5)

Table 10

NAVAL ACTIVITIES--COUNTIES
BY TPD_5

Lower Limit (TPD_5)	Upper Limit (TPD_5)	Absolute Frequency	Relative Frequency (Percent)	Cumulative Relative Frequency (Percent)
0.00	5.00	50.00	48.54	48.54
5.00	10.00	10.00	9.71	58.25
10.00	15.00	6.00	5.83	64.08
15.00	20.00	3.00	2.91	66.99
20.00	25.00	5.00	4.85	71.84
25.00	30.00	5.00	4.85	76.70
30.00	35.00	3.00	2.91	79.61
35.00	40.00	5.00	4.85	84.47
40.00	45.00	1.00	.97	85.44
45.00	50.00	3.00	2.91	88.35
50.00	55.00	1.00	.97	89.32
55.00	60.00	2.00	1.94	91.26
60.00	65.00	1.00	.97	92.23
65.00	70.00	1.00	.97	93.20
70.00	75.00	1.00	.97	94.17
85.00	90.00	1.00	.97	95.15
90.00	95.00	1.00	.97	96.12
95.00	100.00	1.00	.97	97.09
100.00	105.00	1.00	.97	98.06
165.00	170.00	1.00	.97	99.03
180.00	185.00	1.00	.97	100.00
	TOTAL	103.00	100.00	100.00

NOTE: Columns may not add because of rounding.

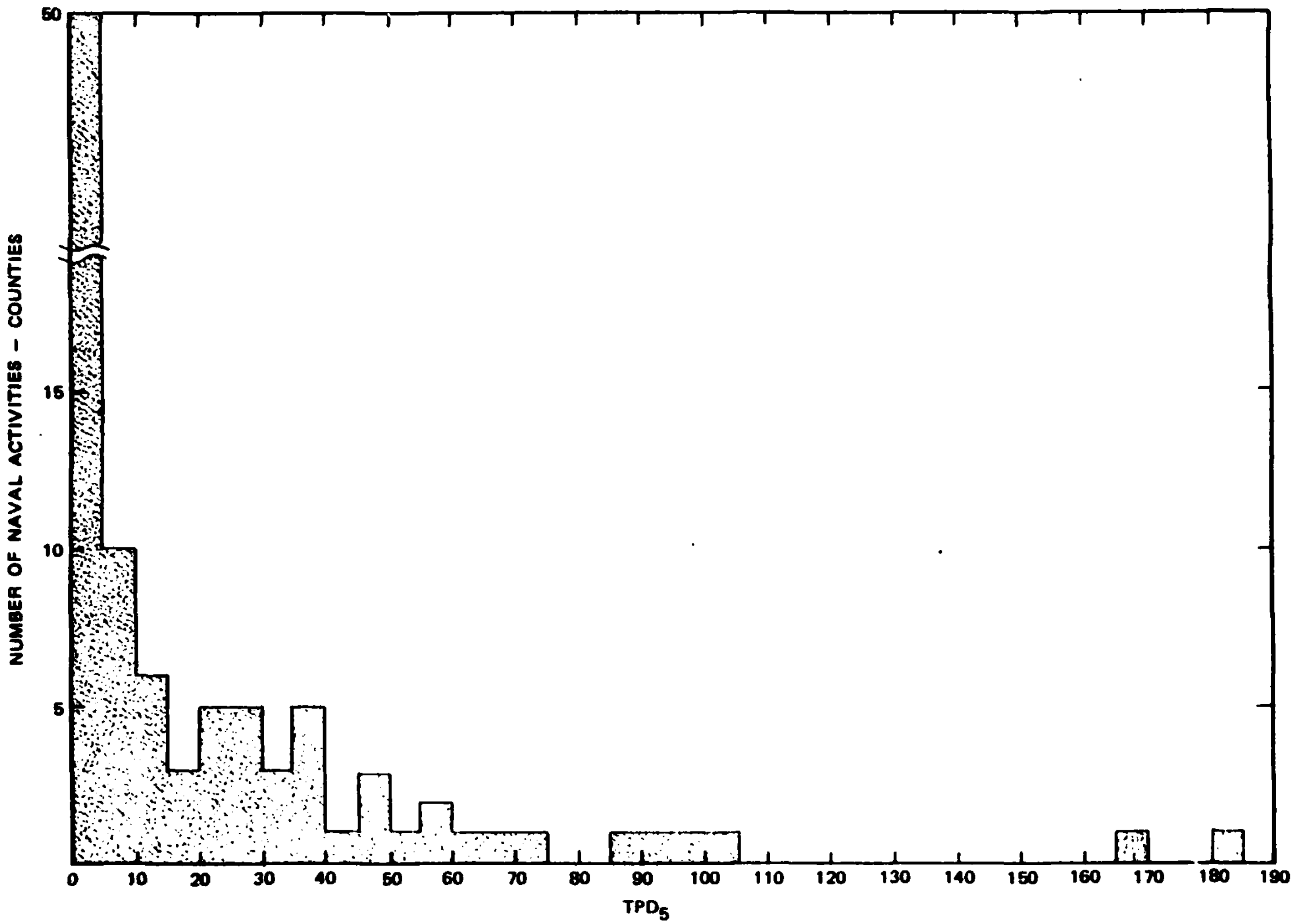


FIGURE 3. NUMBER OF NAVAL "COUNTIES" BY TONS PER DAY (5)

Table 11

NAVAL ACTIVITIES--COMPLEXES
BY TOTAL TPD_5 PER TPD_5 CLASS

Lower Limit (TPD_5)	Upper Limit (TPD_5)	Absolute Tonnage	Relative Frequency (Percent)	Cumulative Relative Frequency (Percent)
0.00	5.00	93.52	4.00	4.00
5.00	10.00	110.13	4.71	8.71
10.00	15.00	144.16	6.16	14.87
15.00	20.00	197.02	8.43	23.30
20.00	25.00	149.76	6.40	29.70
25.00	30.00	187.34	8.01	37.71
30.00	35.00	93.10	3.98	41.69
35.00	40.00	181.10	7.74	49.44
40.00	45.00	127.51	5.45	54.89
45.00	50.00	242.11	10.35	65.24
50.00	55.00	105.38	4.51	69.75
55.00	60.00	58.35	2.50	72.25
60.00	65.00	63.22	2.70	74.95
65.00	70.00	136.03	5.82	80.77
70.00	75.00	74.57	3.19	83.96
80.00	85.00	80.80	3.46	87.41
135.00	140.00	136.49	5.84	93.25
155.00	160.00	157.92	6.75	100.00
	TOTAL	2338.51	100.00	100.00

NOTE: Columns may not add because of rounding.

Table 12

NAVAL ACTIVITIES--COUNTIES
BY TOTAL TPD_5 PER TPD_5 CLASS

Lower Limit (TPD_5)	Upper Limit (TPD_5)	Absolute Tonnage	Relative Frequency (Percent)	Cumulative Relative Frequency (Percent)
0.00	5.00	52.57	2.54	2.54
5.00	10.00	66.27	3.20	5.74
10.00	15.00	72.82	3.52	9.25
15.00	20.00	56.99	2.75	12.00
20.00	25.00	105.59	5.10	17.10
25.00	30.00	139.69	6.74	23.85
30.00	35.00	97.93	4.73	28.57
35.00	40.00	183.06	8.84	37.41
40.00	45.00	43.80	2.11	39.52
45.00	50.00	145.77	7.04	46.56
50.00	55.00	51.38	2.48	49.04
55.00	60.00	116.32	5.62	54.66
60.00	65.00	63.22	3.05	57.71
65.00	70.00	69.32	3.35	61.06
70.00	75.00	74.57	3.60	64.66
85.00	90.00	89.78	4.33	68.99
90.00	95.00	91.72	4.43	73.42
95.00	100.00	96.22	4.65	78.06
100.00	105.00	102.76	4.96	83.02
165.00	170.00	169.89	8.20	91.23
180.00	185.00	181.74	8.77	100.00
	TOTAL	2071.41	100.00	100.00

NOTE: Columns may not add because of rounding.

Characterizing Navy Solid Waste

The foregoing analyses of Navy solid waste composition and generation rate defined the nature of two parameters that are critical to design and evaluation of resource recovery system options. The analyses also showed that the generation rate parameter could be "typified" in simple tons-per-day classes. On the other hand, the analyses of composition revealed the complex nature of this second parameter which, even after generalization, retain site-related factors. For this study (which was designed to accommodate "classes" or "types" but not site-specific variations within the classes), we assumed an average of compositions, and a constant composition for all generation rate classes. The values of Table 5 derived from the NACWIS reports were provided to others working on the project to depict the "average composition." A correlation between activity size (i.e., tons/day) and composition in one or more of the waste/origin elements might be found with a larger, more complete data set. Perhaps regressions should be run to check on this possibility after approximately 50 R^4 reports are completely documented.

Solid Waste Collection and Disposal Practices

Characterization of Navy Activities

In an attempt to categorize the Navy solid waste handling practices, the NACWIS file data were analyzed on the basis of costs and physical attributes. The limitations of the current data were immediately apparent as is noted below.

Collection, Transportation, and Disposal Costs. NACWIS data were reviewed and compiled by TPD_5 to determine the total cost per ton of collecting, transporting, and disposing of Navy solid waste. We calculated these costs for the functions performed by both the Navy and by private contractors (see Figure 4 and Tables 13 and 14).

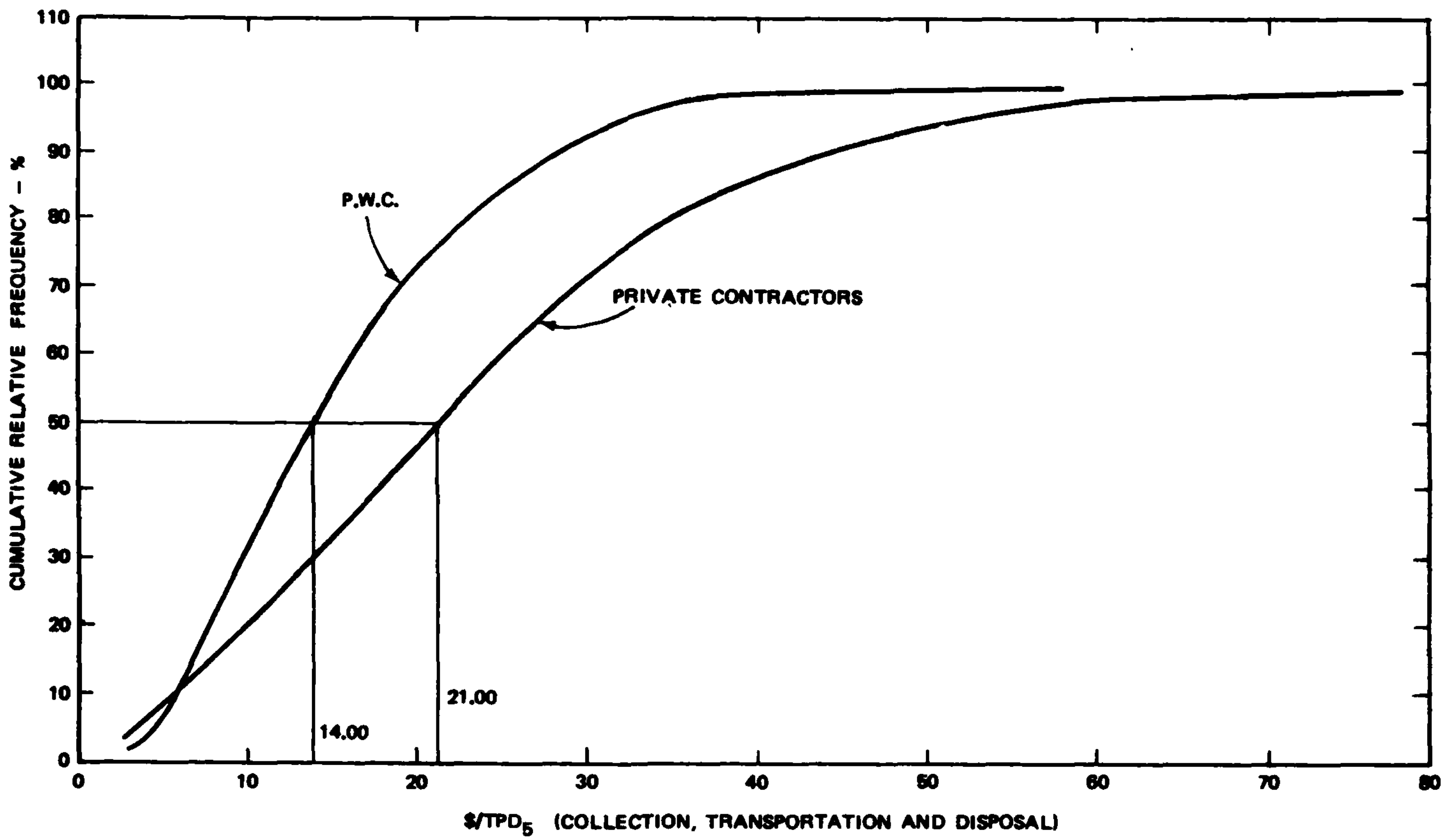


FIGURE 4. COLLECTION, TRANSPORTATION, AND DISPOSAL COST BY PWC AND PRIVATE CONTRACTORS

Table 13

COLLECTION, TRANSPORTATION, AND DISPOSAL COSTS BY TPD_5 BY PWC

Lower Limit (TPD_5)	Upper Limit (TPD_5)	Absolute Frequency	Relative Frequency (Percent)	Cumulative Relative Frequency (Percent)
3.00	4.00	1.00	1.75	1.75
4.00	5.00	3.00	5.26	7.02
5.00	6.00	4.00	7.02	14.04
6.00	7.00	2.00	3.51	17.54
7.00	8.00	1.00	1.75	19.30
8.00	9.00	3.00	5.26	24.56
9.00	10.00	2.00	3.51	28.07
10.00	11.00	3.00	5.26	33.33
11.00	12.00	3.00	5.26	38.60
12.00	13.00	4.00	7.02	45.61
13.00	14.00	5.00	8.77	54.39
14.00	15.00	2.00	3.51	57.89
15.00	16.00	2.00	3.51	61.40
16.00	17.00	4.00	7.02	68.42
18.00	19.00	2.00	3.51	71.93
19.00	20.00	2.00	3.51	75.44
20.00	21.00	1.00	1.75	77.19
22.00	23.00	1.00	1.75	78.95
24.00	25.00	3.00	5.26	84.21
25.00	26.00	1.00	1.75	85.96
26.00	27.00	1.00	1.75	87.72
27.00	28.00	1.00	1.75	89.47
28.00	29.00	2.00	3.51	92.98
30.00	31.00	2.00	3.51	96.49
40.00	41.00	1.00	1.75	98.25
56.00	57.00	1.00	1.75	100.00
	TOTAL	57.00	100.00	100.00

NOTE: Columns may not add because of rounding.

Table 14

COLLECTION, TRANSPORTATION, AND DISPOSAL COSTS
BY TPD_5 BY PRIVATE CONTRACTOR

Lower Limit (TPD_5)	Upper Limit (TPD_5)	Absolute Frequency	Relative Frequency (Percent)	Cumulative Relative Frequency (Percent)
3.00	4.00	2.00	3.51	3.51
4.00	5.00	3.00	5.26	8.77
5.00	6.00	1.00	1.75	10.53
7.00	8.00	2.00	3.51	14.04
8.00	9.00	3.00	5.26	19.30
9.00	10.00	1.00	1.75	21.05
11.00	12.00	3.00	5.26	26.32
12.00	13.00	1.00	1.75	28.07
13.00	14.00	2.00	3.51	31.58
14.00	15.00	2.00	3.51	35.09
17.00	18.00	1.00	1.75	36.84
18.00	19.00	1.00	1.75	38.60
19.00	20.00	5.00	8.77	47.37
20.00	21.00	1.00	1.75	49.12
21.00	22.00	2.00	3.51	52.63
23.00	24.00	3.00	5.26	57.89
24.00	25.00	1.00	1.75	59.65
26.00	27.00	1.00	1.75	61.40
27.00	28.00	2.00	3.51	64.91
28.00	29.00	1.00	1.75	66.67
29.00	30.00	2.00	3.51	70.18
31.00	32.00	2.00	3.51	73.68
32.00	33.00	1.00	1.75	75.44
33.00	34.00	1.00	1.75	77.19
34.00	35.00	3.00	5.26	82.46
38.00	39.00	1.00	1.75	84.21
39.00	40.00	1.00	1.75	85.96
40.00	41.00	1.00	1.75	87.72
43.00	44.00	1.00	1.75	89.47
45.00	46.00	1.00	1.75	91.23
46.00	47.00	1.00	1.75	92.98
54.00	55.00	2.00	3.51	96.49
57.00	58.00	1.00	1.75	98.25
77.00	78.00	1.00	1.75	100.00
	TOTAL	57.00	100.00	100.00

NOTE: Columns may not add because of rounding.

Figure 4 shows that the Naval complexes currently served by the PWC are reportedly less costly than those served by private collectors. However, it is not certain that both costs are computed on the same basis. The cost difference could be due to costs taken into account by private collectors but not in the PWC reports. The costing ground rules for these data were unavailable. The relative economics of scale for collection are shown in Figure 5 for three sizes of Naval complexes.

Little to no information was available about collection vehicles (i.e., type, quantity or remaining useful life) or about containers. Information about personnel involved in solid waste collection was also unavailable.

Landfills

Information about 143 Navy solid waste activities* is contained in the NACWIS data base. Table 15 shows the distribution of these activities by location and volume in tons per day. Note that more than half of the sites are off-base at sanitary landfills or disposal sites operated by municipalities or private haulers. More than half of the total volume of solid waste is disposed off-base. On the other hand, 3% of the sites have been characterized as open dumps by the Navy. Although the absolute number of open dumps is not known, it is safe to assume that, under RCRA guidelines, these sites must be upgraded or closed. In addition, some of the existing sanitary landfills may ultimately be listed as open dumps under the state inventories. At a minimum, it is possible that 5% of Navy solid waste disposal activities could be classified as open dumps under RCRA.

---

*Landfill data are missing on approximately 40% of the activities listed in the complexes. Whether the data analyzed are truly representative of the Navy as a whole thus could not be determined.

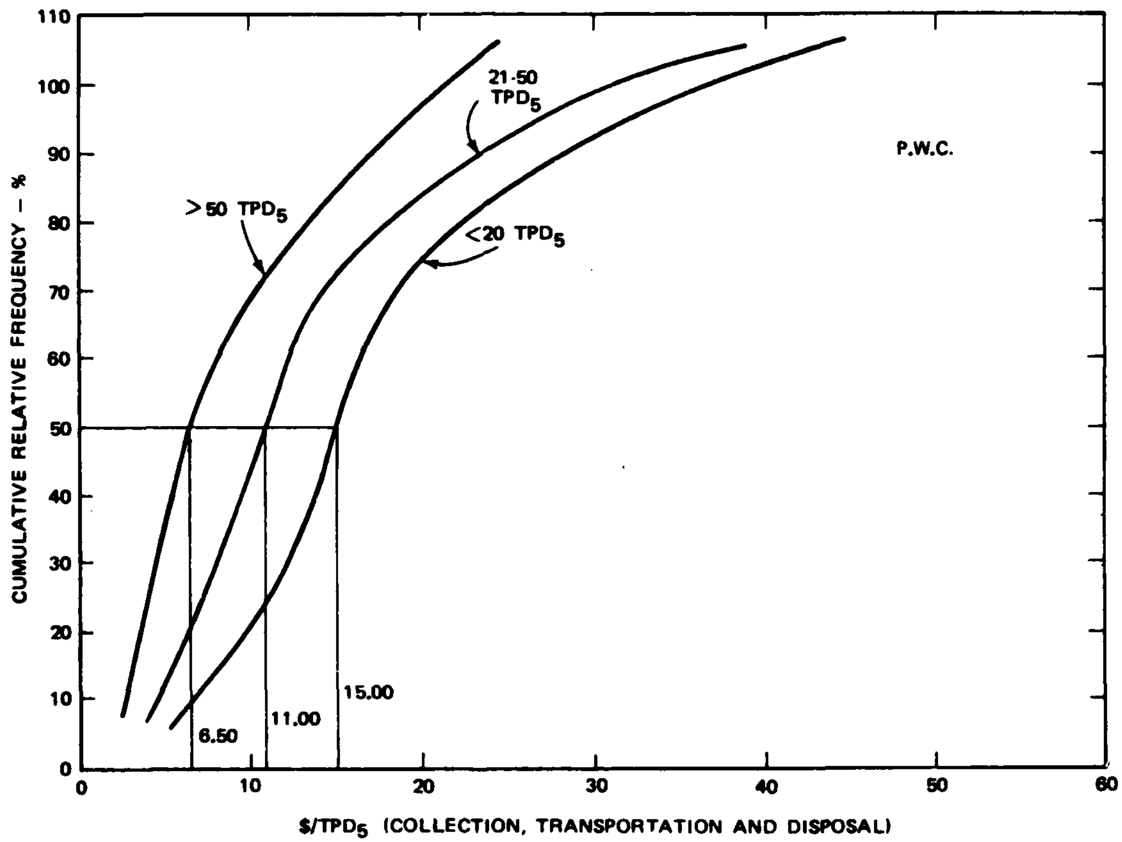


FIGURE 5. PWC COLLECTION, TRANSPORTATION, AND DISPOSAL COST FOR 3 SYSTEM SIZES

Table 15

CHARACTERISTICS OF REPORTED
NAVY SOLID WASTE LANDFILL SITES

Location of Site	Number of Sites	Percent of Total	Volume TPD_5	Percent of Total
On-base sanitary landfills and related activities	56	39	1,056	43
On-base open dumps	5	3	149	6
Off-base sanitary landfills, private landfills, related activities	82	57	1,295	52
TOTAL	143	100	2,500	100

Note: Columns may not add because of rounding.
Source: NACWIS data base (July 1978).

Table 16 indicates the remaining site life for 38 Navy solid waste activities. If this sample is representative, 45% of all navy sites must be expanded or replaced within 7 years. Applying this figure to the 159 sites from which information is available, we estimate that more than 70 sites have sufficient capacity to remain in operation only 7 years or less. On the other hand, 24% of the sites have ample capacity (site life more than 15 years) and may continue to operate unless found in violation of RCRA regulations by the states. Because of the many Navy solid waste activities that must be expanded or replaced within the next decade, the requirements under RCRA and SDWA will undoubtedly substantially affect Navy planning decisions.

The average size of Navy on-base solid waste activities (from Table 1) listed in the NACWIS data base is 20 TPD_5 and the range is from 1 to 80 more than TPD_5. The distribution of facilities according to size is shown in Table 17. Note that 89% have a daily volume less than or equal to 40 TPD_5. Operations of this size are quite small compared to municipal landfills for moderate-sized cities.

Table 16

REMAINING SITE LIFE FOR SELECTED NAVY SOLID WASTE ACTIVITIES

Remaining Site Life (Years)	Number of Sites	Percent of Total
less than 3	14	37
3-7	3	8
8-15	12	31
more than 15	9	24
TOTAL	38	100

Source: NACWIS data base (July 1978).

Table 17

DISTRIBUTION OF NAVY SOLID WASTE FACILITIES BY SIZE

Size of Facility (TPD5)	Number of Facilities	Percent of Total
less than 15	70	57
16-40	39	32
41-80	11	9
more than 80	3	2
TOTAL	123	100

Source: NACWIS data base (July 1978)

EPA has estimated costs on the basis of facility sizes for upgrading existing landfills and for meeting RCRA monitoring and control requirements (see Appendix C). Because 57% of Navy solid waste activities have an operational volume of less than or equal to 15 TPD_5 (equivalent to 10.7 TPD_7 in Appendix C), that size will be used in estimating rough cost figures for Navy facilities. Table 18 contains a breakdown of costs per ton, based on each RCRA criterion. For comparative purposes, costs to meet all requirements are included. Although each cost would not apply to every site, some estimates of possible increased costs can be made.

Table 18

ESTIMATED COSTS OF UPGRADING NAVY LANDFILLS TO MEET VARIOUS RCRA REQUIREMENTS (In 1977 Dollars)

Requirement	Annualized Cost/Site*	Added Cost/Ton
Water Quality		
Environmentally sensitive areas		
Wetlands, floodplains	7,660	1.96**
Permafrost	1,200	0.32**
Critical habitat	0	0**
Sole-source aquifer	1,200	0.31**
Surface water		
Nonpoint source controls	2,400	0.62
Ground water	10,500	2.69
Air Quality	800	0.21
Safety		
Gas controls	7,900	2.03
Fire	200	0.05
Access	400	0.10
Bird hazard	1,200	0.31
Disease Vectors	27,400	7.03
Aesthetics	700	0.18

*Refer to Appendix C. These estimates only include costs of meeting requirements not covered under other federal legislation.

**These estimates assume that upgrading is possible to meet RCRA requirements. Some facilities may be closed if contamination problems are found to be too extensive or impossible to control.

For example, if a Navy solid waste facility is operated in a wetland or a floodplain, the facility may have to close unless it can be demonstrated that no potential for contamination exists. Costs to upgrade the facility may range fom $1.96 to $5.27/ton of waste. Controls on nonpoint sources of pollutants and to protect ground water may cost as much as $3.00/ton. Therefore, in selecting the location of future solid waste facilities, costs can be minimized by avoiding areas with potential environmental contamination problems. See Appendix D for issues related to water quality.

IV CONCLUSIONS AND RECOMMENDATIONS

Two conclusions were reached from the analyses performed to classify Navy solid waste and Navy solid waste handling practices:

1. Waste/origin R^4 data files, critical to defining recoverable resource values at a given activity, should be updated periodically (quarterly is suggested) over a year or so. The modified survey technique that SRI has developed appears to offer a cost-saving procedure that can produce adequate data.

2. Landfill data are urgently needed for more thorough analysis than was possible with the available data in regard to cost and mission impacts of RCRA and SDWA on Navy activities.

Therefore, SRI recommends:

1. Amending the current Navy R^4 procedures to institute a survey technique similar to the 12-step process outlined in Appendix B. Several volume/weight checks should be performed throughout the year with results reported yearly, perhaps as part of the Environmental Engineering Survey.

2. Initiation of a comprehensive effort to upgrade landfill data. The following steps are suggested:

o Collect information on Navy solid waste activities, including: number of activities, type of activity, volume of waste handled, location, site life, proximity to environmentally sensitive areas, existence of ground or surface water problems, existence of ground or surface water monitoring devices, and techniques employed to reduce potential contamination problems (e.g., pit lining, and leachate collection and treatment).

- Consult with EPA concerning the final criteria for classification of solid waste disposal facilities to be published in July 1979. A site classification manual that describes how to decide which sites meet RCRA requirements will be available from EPA by August 1979.

- Consult with state solid waste officials concerning the facility inventory before September 1979. By that time, state officials will have developed a priority list of sites to inventory in the first year. A new list will be developed for every following year until all sites have been inventoried (expected to be completed within 5 years).

- Available information indicates that many Navy solid waste facilities may need to be expanded or replaced within 7 years. Planning should begin now to assure that site locations are selected to conform with RCRA requirements.

- Better cost data should be developed. The costs to upgrade existing operations are not well known because much depends on specific site characteristics. The Navy should evaluate its operations to determine whether facilities should be closed or upgraded. Those to be upgraded can then be evaluated on the basis of general knowledge of the location (e.g., wetland or floodplain), the volume of waste handled, and the ground and surface water conditions.

APPENDIX A

DESCRIPTION OF COMPUTER DATA MANAGEMENT PROCEDURES

The data management and computational activities discussed in this report were performed on SRI's CDC 6400 computer. The software packages used were

(1) The KRONOS operating system designed for the SRI CDC 6400 and its local communication network

(2) SIR (Scientific Information Retrieval) data base management system

(3) CDC 6400 Extended FORTRAN language

(4) SPSS (Statistical Package for the Social Sciences)

These software systems and their use in this volume are described below. Figure A, a work-flow diagram of the computational sequence, indicates the software used at each step.

KRONOS Operating System

The KRONOS Time-Sharing System was developed by Control Data Corporation (CDC) to provide remote interactive job processing for various computers, including the CDC 6400. The KRONOS system was used in this project for accessing other software, sorting temporary data files at different stages of input and output, constructing programs, and transferring information between software systems and programs.

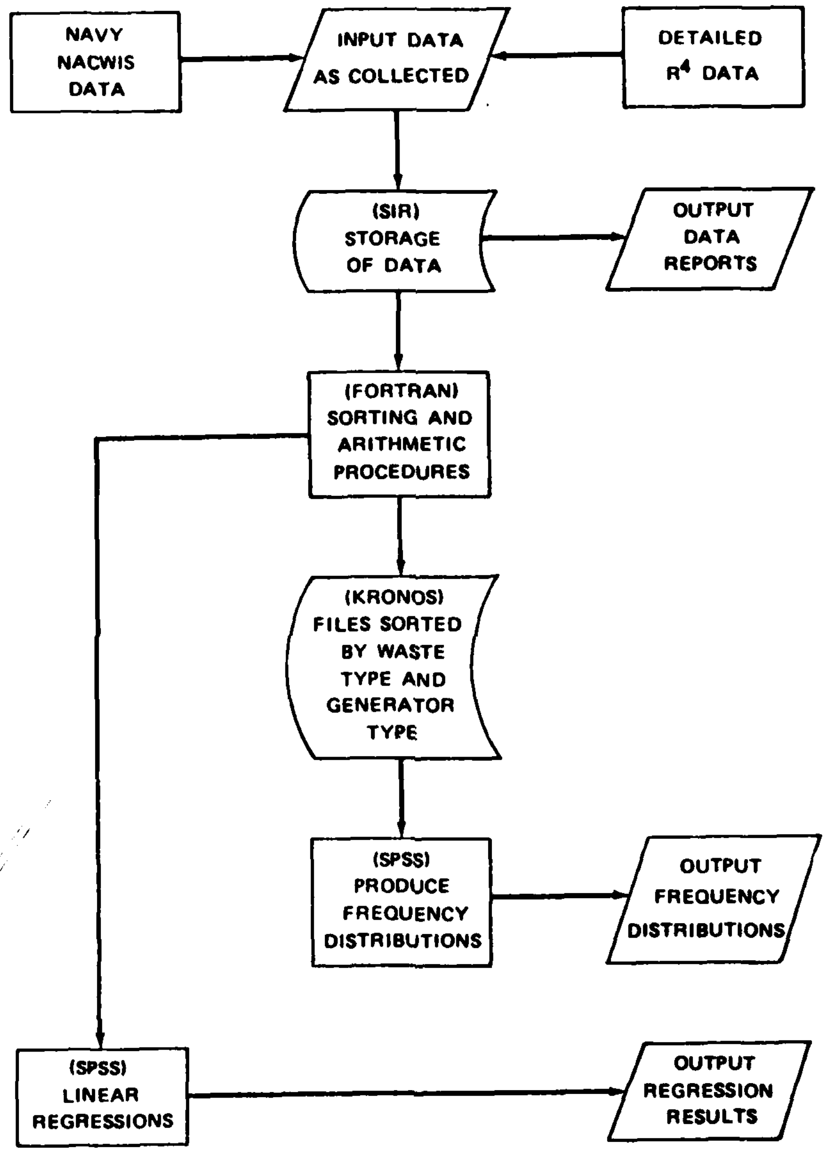


FIGURE A. WORK-FLOW DIAGRAM

SIR

The SIR data base management system is designed for data storage and retrieval, manipulation and control of data, description of data, and security protection of data. It has a hierarchical structure that is used to organize data into sets and groups, and it employs the relationships among these sets and groups in manipulating information. Using SIR, information can be added to a data base, used in computations, graphs, and statistical procedures, and collected into data reports.

An important advantage of SIR is that it uses a language patterned after SPSS language. Two advantages result:

(1) The SPSS package is familiar to many researchers, and, therefore, its language is widely known.

(2) SIR can interface directly with the SPSS package.

In this project, the SIR system was used to store and retrieve solid waste generation and disposal data, as well as R^4 data, to generate frequency distributions and reports, and to compute statistics in combination with SPSS.

A frequency distribution is a graphical representation of the similarities among data in a particular set. For example, a graph of total weights for all waste collection loads might show that one load was under 500 lb, ten loads were between 1000 lb and 1500 lb, and two loads exceeded 2000 lb. The graph shows the frequency of observations (load weights) for each weight or defined ranges of weight. From this graph and related statistical computations, characteristics such as the total range, median and mean values, and standard deviations can be seen.

CDC 6400 Extended FORTRAN

The CDC 6400 version of standard FORTRAN was used to sort data files held in the SIR system and to carry out arithmetic computations using the data. This FORTRAN language is a version of the common FORTRAN programming language that has been tailored for use on the CDC 6400. The sorting activities included the retrieval of data files and resequencing of the information on the basis of certain attributes identified in each data base. Specifically, data stored in a random sequence were ordered into two new files in sequence according to waste generator type in one file and acording to waste type in the other. FORTRAN programs were used to perform summations using the new sorted files, to calculate bulk load densities, and to prepare new files for input to SPSS.

SPSS

SPSS is a package containing subprograms to carry out a multitude of arithmetic, graphical, and statistical procedures. It is used to analyze data, test hypotheses, plot, and to do many other activities. In this report, SPSS was used to perform regression analyses for coefficient estimation and to test confidence levels of the coefficients generated.

Regression analysis is a technique used to generate the coefficients for an equation that can describe the relationship between a measured variable (like volumes of each waste type) and an unknown variable (the weight of a load consisting of a certain mix of waste types). In the regression analysis, the observations of the "independent" variables (e.g., volumes of waste types) and the "dependent" variable (i.e., weight of a load) are compared to determine coefficients that represent the relationship between the variables (here, the densities of each waste type).

Once the coefficients are found, the regression package constructs a predictive equation using the coefficients, calculates predicted values for the dependent variable, and compares the predicted value with the observed value. These comparisons are expressed in various statistical measures that indicate the reliability of the predictive equation.

The regression technique used in this case is "step-wise multiple linear regression." The SPSS subprogram is called REGRESSION. It assumes that the dependent variable is linearly related to the independent variables (more than one independent variable is allowed). The subprogram uses the most common method of regression analysis and produces a wide range of descriptive statistics about the data (e.g., mean, standard deviation, residuals), as well as statistics describing the reliability of the predictive equation such as confidence intervals, T- and F-tests, correlation coefficients, and variance and covariance.

APPENDIX B

MODIFIED WASTE CHARACTERIZATION PROCEDURE

Field Survey/Data Collection Steps

(1) Obtain necessary authorization for survey

(2) Obtain (limited) clearances for survey personnel to use photographic equipment in connection with survey

(3) Arrange to meet with the refuse collector

(4) Obtain map(s) showing location of refuse containers

(5) Obtain a copy of the refuse collection contract (if collected under contractual agreement)

(6) Determine the availability of truck scales

(7) Field check the location of containers, determine their cubic-yard capacity, and number all refuse containers

(8) Map or verify the location on the map on each container

(9) Identify the probable generation origins and waste types that each container should contain on the basis of the building(s) or areas each container serves

(10) Make physical inspections (2 or 3 days) to verify that waste categorization is reasonably accurate

(11) Determine the customary refuse collection truck route(s)

(12) Make field observations of waste collected:* (a) view waste before refuse collection pickup to estimate container volume, (b) follow collection truck to identify containers emptied, and (c) weigh total waste collected.

Analytical Steps (Each Day)

(1) Sum volumes of like generator/origins

(2) Multiply summed volumes by generator/origin density factors shown below to obtain generator weights:

	Lb/yd^3
Housing	91
Office	66
Industrial	113
Medical	69
Ships	144
Food service	110
Recreational areas	81
Dormitory	50
Storage Areas	55

(3) If total day's waste was weighed, sum the weights obtained in step (2) and compare that weight with the actual weight. Note variance. If waste is generated and placed in containers without packing (typical for Navy handling), variance should be within ± 20%.

(4) If an estimate of waste composition (weights of elements) is desired, multiply weights in step (2) above by percentages shown in Table B-1. The estimated composition may then be converted to weights of combustibles and noncombustibles, if desired.

---

*The attached form may be used to record observations. SRI tape-recorded observations, and at end of day, transcribed observations to a similar form.

CONTAINER COLLECTION FORM

Observer(s): ______________________________

Date: ________________ Time: ________________

Container #: ________________ Container size: ________________

Building #: ________________ Container type: ________________

Weather conditions:

Container volume:

- Empty ________
- 25% full ________
- 50% full ________
- 75% full ________
- 100% full ________

Generator/Origins

- Housing ________
- Office ________
- Industrial ________
- Commercial ________
- Medical ________
- Ship waste ________
- Food service ________
- Recreation areas ________
- Dorm waste ________
- Storage ________
- Other ________________________

____

____

____

General Comments:

Table B-1

WASTE TYPE, BY GENERATOR/ORIGIN
(Percent by Weight)

Generator/Origin	Paper	Cardboard	Plastic/ Rubber	Wood	Yard Waste	Food Waste	Metal	Glass	Inerts	Construction
Housing	48%	6%	3%	5%	9%	12%	7%	6%	3%	0%
Office	75	21	0	2	2	t	t	0	0	0
Industrial	54	22	t	12	8	2	2	0	t	0
Commercial	47	52	0	1	t	t	t	0	0	0
Medical	85	14	1	1	t	0	t	0	0	0
Ships	38	26	1	12	3	14	4	0	0	0
Food service	47	33	3	1	1	13	2	t	0	0
Storage areas	68	23	1	4	4	t	t	0	0	0
Recreation areas	49	30	2	1	7	5	3	2	0	0
Dormitories	22	72	t	1	1	2	2	0	0	0

t = trace.

Rows may not add to 100 due to rounding.

APPENDIX C

LANDFILL TECHNOLOGY COSTS PER SITE BY SITE SIZE

LANDFILL TECHNOLOGY COSTS PER SITE BY SITE SIZE

(IN 1977 DOLLARS)

Criterion	Site Size*	Capital Cost (Materials, Machines, Labor)	O & M Costs	Annual Cost	Annualized Cost (Assuming 3rd. yr. Implementation)
Environmentally Sensitive Areas					
-Wetlands, Floodplains	10	63,000	0	10,200	7,660
	100	139,000	0	22,500	16,900
	300	227,000	0	36,800	27,600
	700	328,000	0	56,100	39,400
-Permafrost	N/A	10,000	0	1,600	1,200
-Sole Source Aquifers	N/A	10,000	0	1,600	1,200
-Critical Habitats	N/A	0	0	0	0

*Site size is in tons per day on a seven-day per week basis; to convert to T/D_5 multiply size by 1.4.

Criterion	Site Size	Capital Cost (Materials, Machines, Labor)	O & M Costs	Annual Cost	Annualized Cost (Assuming 3rd. yr. Implementation)
Surface Water	10	20,000	0	3,200	2,400
-NPS Controls	100	80,000	0	13,000	9,600
	300	200,000	0	32,000	24,000
	700	400,000	0	65,000	48,800
Ground Water	10	66,000	3,200	13,400	10,455
	100	262,000	10,600	53,300	40,044
	300	665,000	26,900	134,900	101,360
	700	1,339,000	53,800	405,300	304,375
Air	10	6,600	0	1,000	800
	100	30,800	0	5,000	3,900
	300	82,500	0	13,300	10,000
	700	170,500	0	27,600	20,700

Criterion	Site Size	Capital Cost (Materials, Machines, Labor)	O & M Costs	Annual Cost	Annualized Cost (Assuming 3rd. yr. Implementation)
Safety					
-Gas Controls	10	40,000	4,000	10,500	7,900
	100	88,000	8,800	23,000	17,300
	300	108,000	10,800	28,000	21,000
	700	156,000	15,600	40,800	30,600
-Fire	10	1,000	100	260	200
	100	2,000	500	800	600
	300	10,000	1,000	2,600	2,000
	700	20,000	2,000	5,200	3,900
-Access	10	3,000	0	500	400
	100	6,600	0	1,100	800
	300	10,800	0	1,700	1,300
	700	15,600	0	2,500	1,900
-Bird Hazard	N/A	10,000	0	1,600	1,200

Criterion	Site Size	Capital Cost (Materials, Machines, Labor)	O & M Costs	Annual Cost	Annualized Cost (Assuming 3rd. yr. Implementation)
Disease Vectors	10	-	-	36,500	27,400
	100	-	-	182,500	137,100
	300	-	-	365,000	274,100
	700	-	-	638,750	479,700
Aesthetics					
-Noise		N/A	N/A	N/A	N/A
-Odor		N/A	N/A	N/A	N/A
-Litter	10	1,300	500	700	500
	100	2,800	2,500	2,950	2,200
	300	4,500	5,000	5,700	4,300
	700	6,000	10,000	11,000	8,300
-Dust	10	1,000	100	260	200
	100	2,000	500	800	600
	300	10,000	1,000	2,600	1,900
	700	20,000	2,000	8,500	6,400

APPENDIX D

WATER QUALITY ISSUES RELATED TO NAVY SOLID WASTE DISPOSAL OPERATIONS

Recent legislation has established controls over virtually all activities that might adversely affect water quality. This appendix discusses the two laws that will have the most significant effect on Navy solid waste operations: The Resource Conservation and Recovery Act of 1976 (RCRA) (Public Law 94-580) and the Safe Drinking Water Act (SDWA) (Public Law 93-523). The general requirements under the laws will be discussed, as well as the role of the states in enforcing the legislation, and what the Navy must do to comply.

General Requirements Under the Law

Resource Conservation and Recovery Act of 1976

The U.S. Environmental Protection Agency (EPA) has proposed strict regulations governing the siting and operation of sanitary landfills under RCRA. Provisions are included for phasing out the operation of open dumps.* The proposed "Criteria for Classification of Solid Waste Disposal Facilities" (43 FR 4951) identify areas where sanitary landfills should not be located; establishes restrictions for land application of sludge; and provides guidance for controlling water quality, air quality, and safety problems at the facilities. To minimize duplication, existing federal legislation has been incorporated into the proposed criteria where appropriate.

---

*An open dump is defined as "A site for the disposal of solid waste which does not comply with the Criteria (43 FR 4951)."

The proposed criteria are currently being redrafted by EPA's Office of Solid Waste and will not be available publicly until they are in final form. The final criteria are scheduled to be published in July 1979. The final criteria will contain all the major areas addressed in the proposed criteria, but will also have substantial changes in procedural requirements.

Provisions to protect water quality or to reduce pollutant discharge are key requirements in the proposed criteria. The major requirements relating to water quality are:

- Sanitary landfills cannot be located in environmentally sensitive areas, except under unique conditions. Environmentally sensitive areas are wetlands, floodplains (the area inundated by a 100-year flood), permafrost areas, critical habitats as defined under the Endangered Species Act (Public Law 93-205) and sole-source aquifers (as defined by SDWA).

- The facility must obtain an NPDES permit National Pollution Discharge Elimination System administered under Section 402 of the Federal Water Pollution Control Act Amendments of 1972 (Public Law 92-500) for point-source discharge of pollutants to off-site surface water.

- Nonpoint sources of pollutants to off-site surface water must be minimized and controlled.

- If the facility is located near an aquifer that is or could be used as a source for drinking water,* the site must be prepared and operated to minimize the production of leachate. Any leachate produced must be collected and treated. Ground water in the vicinity must be monitored as long as leachate may be produced.

- When the aquifer is designated for purposes other than drinking water, the quality of ground water beyond the site must be maintained at a level designated by the state.

---

* The restrictions apply if the state designated the aquifer as present or future drinking water supply or if the aquifer contains ground water with 10,000 mg/l of total dissolved solids or less.

- A facility that applies sludge to agricultural land must monitor and control: cadmium levels,* pathogens, pesticides and persistent organics, and direct ingestion.

- Open dumps must be upgraded within 5 years or be closed.

RCRA regulations will be administered through state solid waste offices, with EPA having final approval power over all their actions. The first step is to inventory all existing facilities for the primary purpose of classifying open dumps. Because the determination of open dumps is subject to a great deal of interpretation, EPA will publish a set of guidelines for the states in regard to what constitutes good sanitary landfill practices under the law. In addition, training sessions will be held for state solid waste personnel in each of the EPA regions. Although preliminary information about locations and operators of solid waste facilities is now being generated by the states, no action will take place until after the final criteria are published in mid-1979. The expected timetable for action and the role of the states in enforcement is discussed in Section I of the body of the report.

Safe Drinking Water Act of 1974

Following the discovery that organic chemicals were present in New Orleans' drinking water, Congress passed the SDWA to authorize EPA to establish drinking water standards, protect groundwater supplies from all harmful contaminants, regulate underground injection wells, and establish a federal-state system for assuring compliance. To minimize duplication, RCRA and the proposed criteria make use of specific provisions of SDWA. These include: protection of sole-source aquifers, underground injection control programs, and control of surface impoundments.

---

*Regulation of lead levels may also be included in the final criteria.

Navy operations will be required to meet SDWA standards and regulations. Although Section 1447(b) of the Act allows waivers to the Secretary of Defense in the interest of national security, no waivers have been granted by EPA as of October 1978. Amendments to the original Act have indicated that states have jurisdiction over federal facilities.

Because sole-source aquifers have been identified as environmentally sensitive areas under RCRA's proposed criteria, operation of sanitary landfills has thereby been prohibited in those areas, except under unique conditions. The proposed rule for sole-source aquifers (42 FR 51620) establishes procedures whereby members of the public can petition EPA (or EPA can operate under its own initiative) for designation. An aquifer can be designated if it is the sole or principal drinking water source for an area (i.e., supplies more than 50% of area requirements), and if its contamination would cause a significant health hazard.

Six sole-source aquifers have already been designated under the proposed rule (San Antonio, Texas; Guam; Nassau-Suffolk County, New York; Spokane, Washington, Biscayne, Florida; and Ten-Mile Creek, Maryland). Once a sole-source aquifer is designated, EPA may delay or stop commitment of any federal funds for projects that may contaminate the aquifer. However, the definition of "federal financial assistance" under the proposed rule exempts actions or programs carried out by the federal government and actions performed by contractors for the federal government. These qualifications would seem to exempt most Navy operations from complying with the regulations.

Given that ground water is now being recognized as a critical resource, additional controls at the state level can be expected. Currently, Florida, Indiana, Iowa, and Michigan have regulations protecting sole-source aquifers.

Well injection of wastes is covered under the SDWA and is exempt from the proposed RCRA criteria. The proposed rule for the Underground Injection Control Program (41 FR 36726) will be developed and administered by the states under EPA's guidance. The program includes the development of construction and operation standards, as well as the inspection and monitoring of facilities. All underground injection facilities are subject to the law, regardless of ownership.

Surface impoundments that can impair groundwater quality come under the authority of both SDWA and RCRA. EPA has not yet determined the best regulatory approach to control surface impoundments. However, the state inventories of solid waste disposal facilities will reveal the locations of those impoundments posing the most serious environmental hazard.

Role of the States in Enforcement

RCRA was written giving primary enforcement responsibility to the states, whereas SDWA was written giving primary enforcement responsibility to EPA with the option to pass most of its authority on to the states. Forty states have now been approved for primary enforcement of SDWA.* A special working group has been established within EPA to coordinate activities between the Office of Solid Waste and the Office of Water Supply.

As previously mentioned, the final criteria for the classification of Solid Waste Disposal Facilities are scheduled to be published in July 1979. Within 2 months following publication, the states will begin their inventory. Although the Act calls for completion of the inventory within 1 year, funds and staff are not available to accomplish it, given

---

*The program to designate sole-source aquifers remains under the primary authority of EPA. See Appendix D attachment for details.

the scope of the project. Consequently, EPA will negotiate each year with each state to rank its inventory list in order to designate the worst offenders within 5 years. The actual inspection of the facilities may be done by either state or local agencies.

Each Navy solid waste disposal site will be inspected according to the following general criteria:

- o Proximity to a wetland, floodplain, permafrost area, critical habitat, and sole-source aquifer
- o Existence of (or potential for) water quality problems related to runoff, leachate, operation, or maintenance of the site
- o Capacity
- o Type and daily volume of solid waste
- o Whether operation and maintenance of the site conforms to good sanitary landfill practices
- o Plans for phasing out the disposal operation.

If a facility is not found to be in compliance with the law, the state personnel will notify the operator of the violations. The operator will then have the opportunity to improve conditions. If no impovement is made, the facility will be listed (or, in other words, classified as an open dump) and will have 5 years from that date to comply or to be phased out before it is closed. EPA will offer guidance to state personnel in regard to their inspection programs to assure some consistency. Some of the information collected in the inventory will be used for enforcement of SDWA.

The designation of sole-source aquifer under SDWA is being administered by EPA. Designations are being made at present under the proposed rule. Four aquifers have been designated and two more will be designated by December. Four more aquifers are now under petition but will not be decided until 1979. No solid waste disposal operations will be allowed within the area of a sole-source aquifer unless it can be

proved that no contamination is possible. Existing operations may not be able to meet these requirements without significant expense to upgrade the facility by lining the bottom, collecting and treating leachate and surface runoff, adding additional earth cover, or diverting runoff. In many cases, upgrading may not even be possible to meet requirements under the law. The Navy should determine whether the sole-source aquifer criteria may apply to a location before siting future sanitary landfills.

As discussed in the previous section, six aquifers have been designated or will be designated sole-source aquifers by December 1979 under SDWA. Four of the counties containing designated sole-source aquifers also have Navy facilities (determined from the NACWIS data base): Dade County, Florida; Nassau County, New York; Montgomery County, Maryland; and Guam. Two of these areas, Guam and Maryland, indicate the presence of a Navy sanitary landfill.

Any planned expansion or development of sanitary landfills in the areas containing sole-source aquifers will be carefully reviewed by state and federal agencies to assure conformance with RCRA and SDWA regulations.

Requirements Applicable to the Navy

No information is available at this time to determine how many landfills will be required to comply with RCRA and SDWA regulations. Each state will begin an inventory of all landfills by October 1979 with expected completion in 5 years. The Navy is subject to state jurisdiction under RCRA unless a waiver is granted "in the interest of national security." EPA has not and is not expected to authorize waivers.

Attachment to Appendix D

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

September 13, 1978

Subject: STATUS REPORT: State Primacy for Public Water System Supervision Program

From: OFFICE OF DRINKING WATER (WH-550)
Contact: Ron Singh (472-4160)

FOLLOWING STATES HAVE ASSUMED PRIMACY ON THE INDICATED DATES:

1.	Oklahoma	4-30-77	19.	Texas	01-30-78
2.	Connecticut	5-07-77	20.	Michigan	02-01-78
3.	Louisiana	5-16-77	21.	Maryland	02-13-78
4.	Mississippi	6-20-77	22.	North Dakota	02-18-78
5.	Nebraska	6-23-77	23.	Florida	02-18-78
6.	Alabama	7-10-77	24.	Wisconsin	03-02-78
7.	Arkansas	7-10-77	25.	Nevada	03-30-78
8.	Georgia	8-07-77	26.	Kansas	03-30-78
9.	New York	9-10-77	27.	Montana	03-30-78
10.	Virginia	9-10-77	28.	Idaho	03-30-78
11.	Iowa	9-23-77	29.	Washington	03-30-78
12.	Minnesota	9-26-77	30.	New Mexico	04-02-78
13.	Tennessee	9-30-77	31.	Delaware	04-02-78
14.	S. Carolina	9-30-77	32.	West Virginia	04-02-78
15.	Maine	10-07-77	33.	Colorado	05-07-78
16.	Hawaii	10-20-77	34.	California	06-02-78
17.	Kentucky	10-20-77	35.	New Hampshire	08-18-78
18.	Massachusetts	12-01-77	36.	Trust Terr.	09-19-78
			37.	Guam	09-09-78

FOLLOWING STATES ARE QUALIFIED FOR PRIMACY AND ARE AWAITING PUBLIC COMMENTS PRIOR TO ASSUMPTION OF PRIMACY ON THE INDICATED DATES:

1. Alaska 09-22-78
2. Arizona 09-24-78

FOLLOWING STATES ARE FOUND TO BE QUALIFIED FOR PRIMACY PENDING NOTICE IN THE FEDERAL REGISTER:

1. Rhode Island